Improving Air Quality Forecasting Systems in Korea

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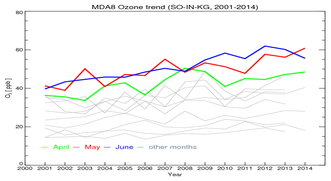
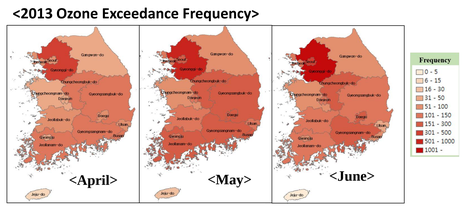
Introduction

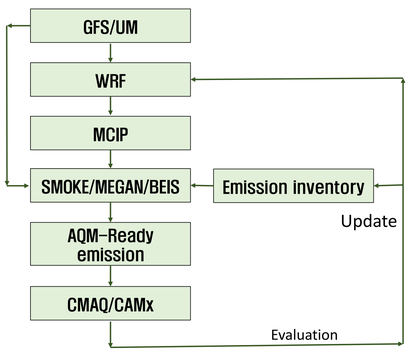
- Air quality forecasting systems that employ various combinations of air quality models, emissions inventories, and meteorological data have been implemented and operated to predict PM_{10} and $PM_{2.5}$, and 1-hr ozone peak concentrations in Korea since May 2012.
- In detail, Community Multi-scale Air Quality (CMAQ) and Comprehensive Air quality Model with eXtensions (CAMx) are utilized for air quality prediction with 2006 the Intercontinental Chemical Transport Experiment-Phase B (INTEX-B) and 2010 Work Plans for Model Inter-Comparison Study - Asia Phase III inventories (MICS-Asia) for regional emissions and Clean Air Policy Support System (CAPSS) for Korean domestic emissions.
- To generate meteorological inputs for each forecasting day, National Centers for Environmental Prediction Global Forecasting System (NOAA/NCEP-GFS) and Korea Meteorological Administration (KMA)-Unified Model (UM) meteorological data area selectively tested in Weather Research and Forecasting (WRF) model simulations to improve forecasting skills for the target species.
- PM and ozone long-term trends over Seoul Metropolitan Area (SMA) are shown below.



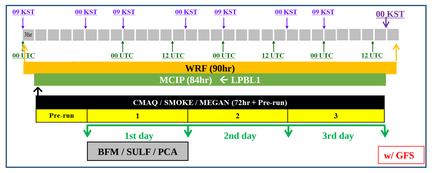


AQF Setup

<AQF system>



<AQF daily operation>



<CMAQ configurations>

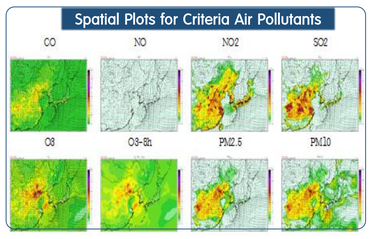
	AQFv1	AQFv2	AQFv3
Run begins @	09 KST	09 KST	09 KST
Initial Met.	GFS 18z	GFS 18z	GFS 18z
Run duration	36 hours	84 hours	36 hours
Pre-run (WRF/CMAQ)	15/12 hours	15/12 hours	15/12 hours
WRF	Version 3.3	Version 3.3	Version 3.3
Emissions	**INTEX-B 2006**	**INTEX-B 2006**	**MICS-Asia 2010**
CAPSS Base Year	**2007**	2007	**2010**
Probing tools	BFM, SULF, PCA	BFM, SULF, PCA	BFM, SULF, PCA

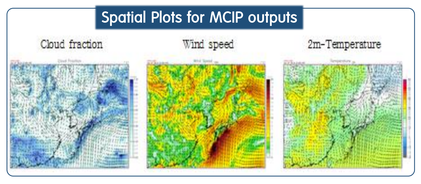
❖ **Meteorological Input Preparation** *"See E. Kim Poster"*

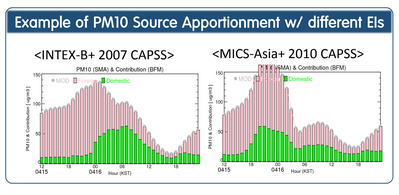
❖ **Emission Inventories for AQF** *"See S. You Poster"*

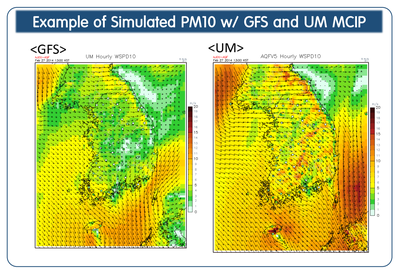
❖ **CMAQ and CAMx Model Setup and Comparison** *"See C. Bae Poster"*

❖ **Examples of Daily Forecast**



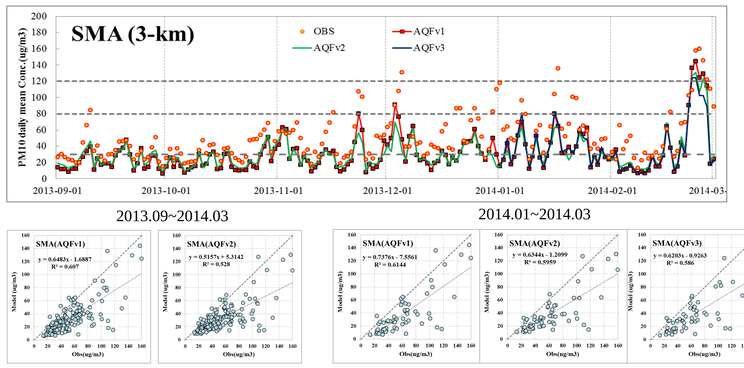




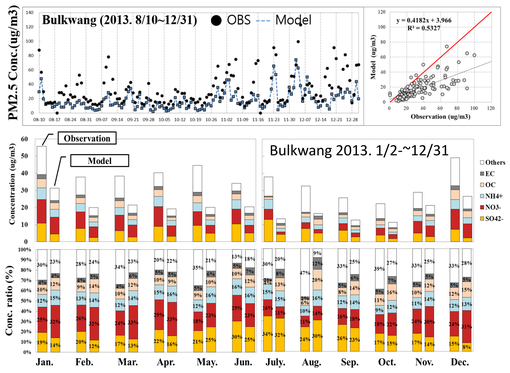


Result 1: CMAQ Forecasts for PM and Ozone

❖ **PM_{10} Concentrations**



❖ **$PM_{2.5}$ Concentrations & Its Composition**

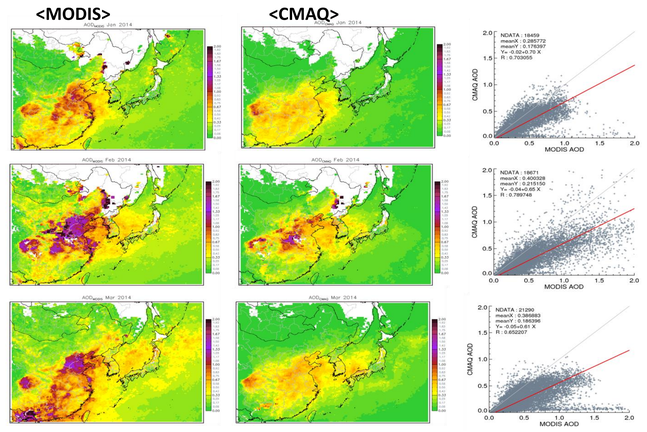


Scatter plots for PM_{10} show the slopes of 0.62~0.73 depending on the AQF configurations.

Bulkwang site is located inside Seoul.

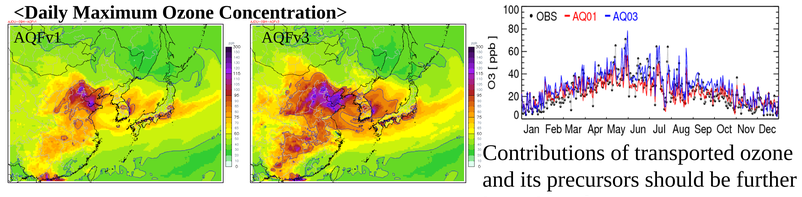
Measured and simulated $PM_{2.5}$ show similar relative seasonal variations. However, the modeled concentrations are mostly lower than the observed concentrations.

❖ **Comparison of monthly MODIS & CMAQ AOD**



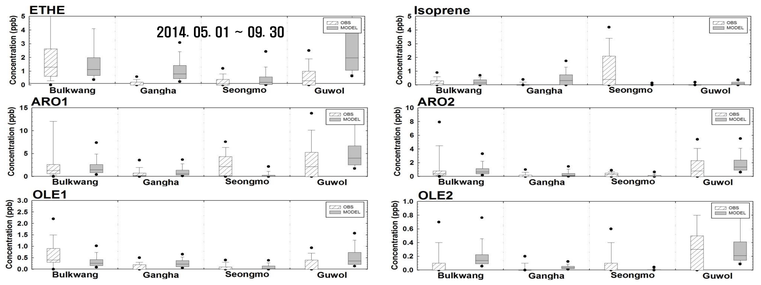
❖ **1-hr Ozone**

<Daily Maximum Ozone Concentration>



Contributions of transported ozone and its precursors should be further investigated.

<Ozone Precursor Conditions inside SMA>

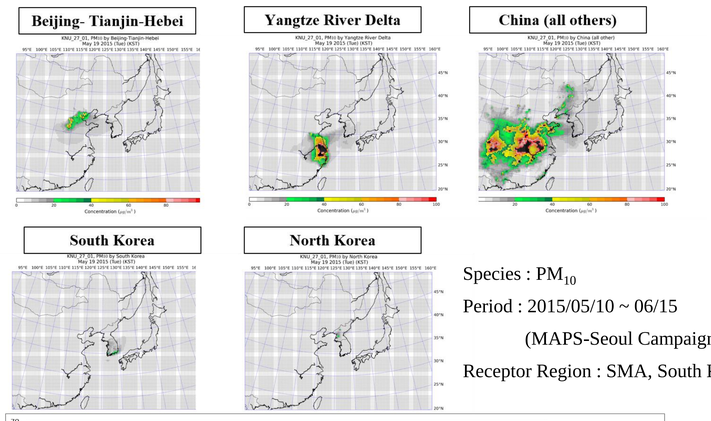


<1-hr Ozone Forecast Statistics>

Period: 2014. 05. 01 ~ 09. 30; unit : %

Province	Accuracy	Detection rate	FAR	Over-prediction	Under-prediction
Seoul	76.5	39.6	17.4	13.9	86.1
Incheon	77.8	32.4	36.8	23.5	76.5
Northern Gyeonggi	76.5	48.3	9.7	11.1	88.9
Southern Gyeonggi	75.8	58.1	6.5	10.8	89.2
Gangwon	88.9	63.9	11.5	17.6	82.4
Chungcheong	76.5	50.8	16.2	16.7	83.3
Cyongsang	75.8	50.0	5.9	5.4	94.6
Jeolla	79.7	51.0	10.3	9.7	90.3
Jeju	88.2	31.3	16.7	38.9	61.1

Result 2: CAMx Forecast for PM and Ozone concentrations and contributions

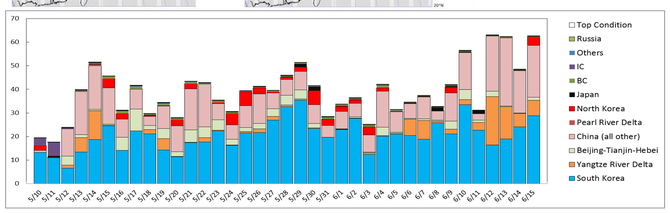


Species : PM_{10}

Period : 2015/05/10 ~ 06/15

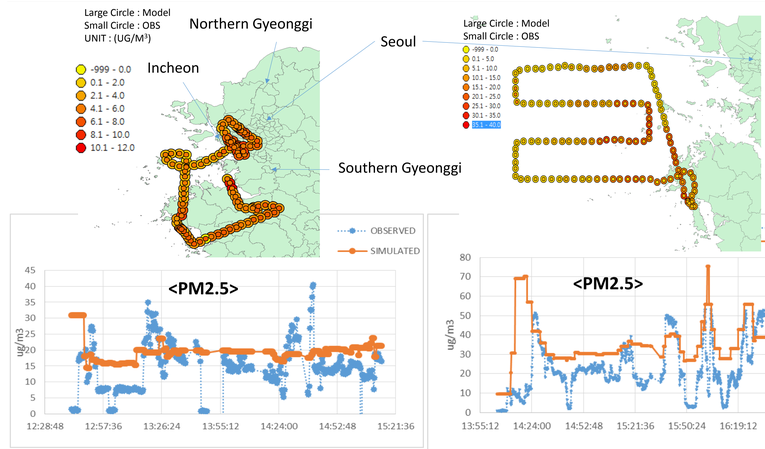
(MAPS-Seoul Campaign Period)

Receptor Region : SMA, South Korea



We will utilize $PM_{2.5}$ source contribution results and comparisons of modeled $PM_{2.5}$ with the observed $PM_{2.5}$ including its composition to update emissions inventory and improve the overall forecasting skill over the region.

Result 3: MAPS-Seoul 2015 Field Campaign Support



Based on what we have learned from the air quality forecasting practice during the 2015 MAPS-Seoul, the AQF system will be updated to support 2016 KORUS-AQ field campaign.

Concluding Remarks

- Long-term comparisons of simulated PM_{10} and $PM_{2.5}$ concentrations to the observed concentrations show consistent under-predictions.
- The modeled-to-measured annual PM_{10} concentration ratio is about 0.7 on average although it shows seasonal variations.
- Ozone peaks were mostly under-predicted especially for large cities. Ozone precursor conditions should be further investigated to improve local ozone production in the model.
- Among inorganic components, sulfate is apparently under-estimated while nitrate and ammonium are comparable to the observations.
- As for future improvement, we consider (1) to incorporate data assimilation with surface measurements and satellite products to revise initial chemical fields for air quality simulations and (2) to add fugitive dust and wild fire emissions to examine the impacts on air quality forecasts. Some of these ensemble members will provide daily forecasts for 2016 KORUS-AQ field campaign.

Acknowledgement

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